Fermilab Machine Shop Operations

Jim Kerby

Technical Division

21 March 2006

Fermilab Machine Shop

The shop provides service to the laboratory for:

- **Quick turnaround tasks**
  - Shutdown requirements; operations
- **Low quantity R&D / pre-production jobs**
  - Prototyping; manufacturing advice / interactions
- **Services not readily available outside the lab**
  - Tolerance requirements & development
  - Specialty welding
- **Radioactive machining capabilities**
  - Risk reduction

Fermilab Machine Shop

The Village Machine Shop is the primary facility (located in Lab 4) and houses (among other things):

- **Our most modern CNC equipment**
  - 2005 Charmilles 440cc Wire EDM w/ Rotary Axis
  - 2004 Haas VF-9 Vertical 4 Axis CNC Milling Machine w/ part probing cap
  - 1999 Haas VF-0E Vertical 4 Axis CNC w/ Rigid Tapping
- **Our Specialty Equipment not available elsewhere**
  - 'Queen' vertical mill, w/ travel 252" x 48" x 72"
- **Assorted older lathes and mills**
- **Main weld shop w/ capabilities in**
  - GTAW, SMAW
  - Plasma Welding
  - Acetylene Cutting to 30"
  - Pressure vessel and structural detail welding

Fermilab Machine Shop

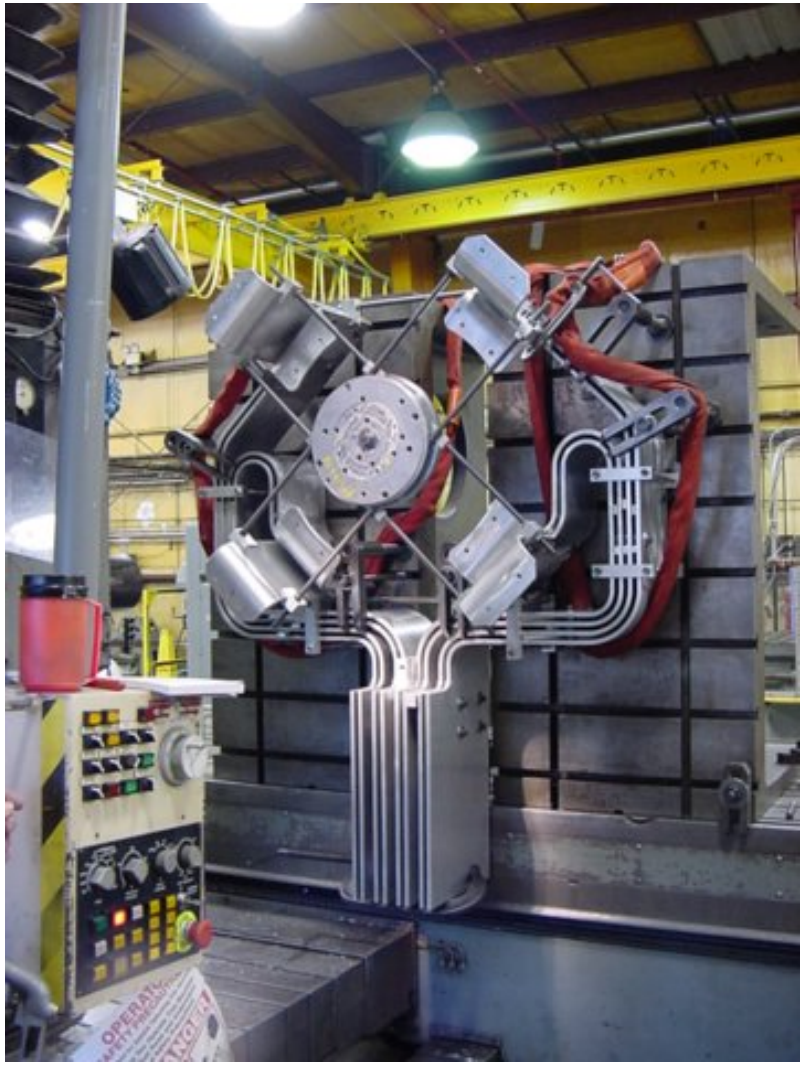
Specialty Tasks include

- **Reworking of NuMI Horn componets**
- **Machining of LHC Cold Mass**
- **Plasma cutting of shielding**

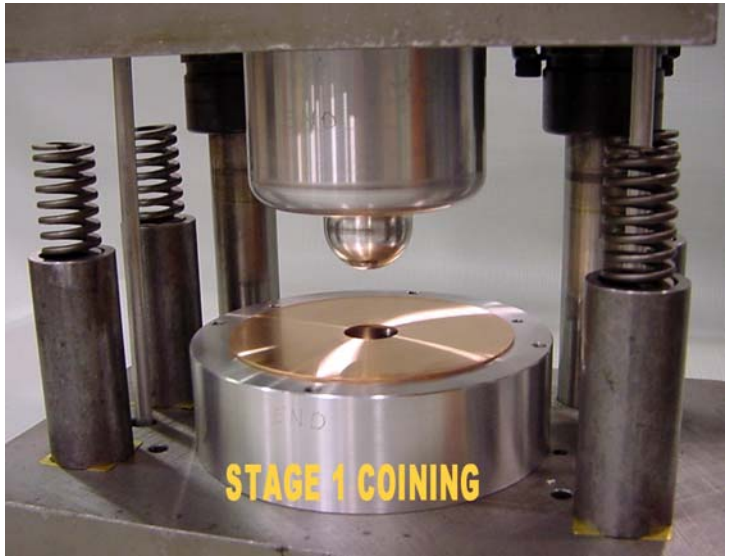
Fermilab Machine Shop

Specialty Tasks include

- **Preliminary and finish machining of NuMI Stripline Assembly**

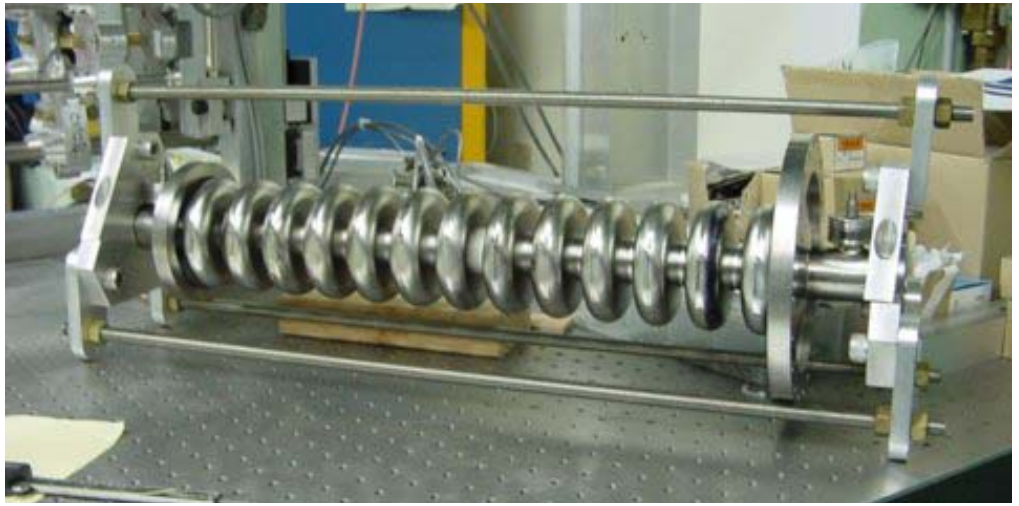


Fermilab Machine Shop



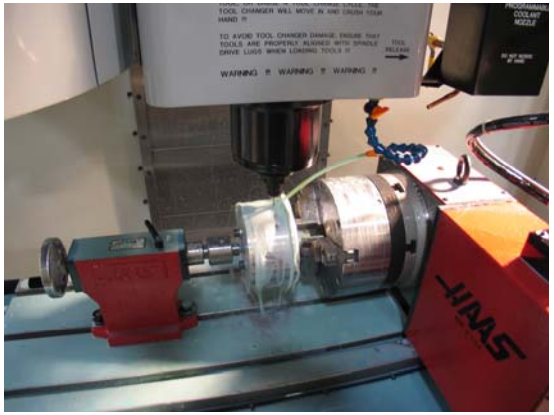
Specialty Tasks include

- **Prototyping of RF cavity production**



Fermilab Machine Shop

Recent upgrades to the shop after many tight years include:



Haas VF-0E CNC Machining Center

Charmilles 440CC Wire EDM

Bridgeport Easypath CNC Lathe

Haas VF-9 4 Axis CNC Milling Machine

Fermilab Machine Shop

The Shop is run as a service to Fermilab, focused on the needs of Fermilab and Fermilab Users.

It is run on a chargeback basis, using a single hourly rate that covers:

- **Salaries and Fringe**
- **Educational and Training Expenses**
- **Normal Machine Repair**

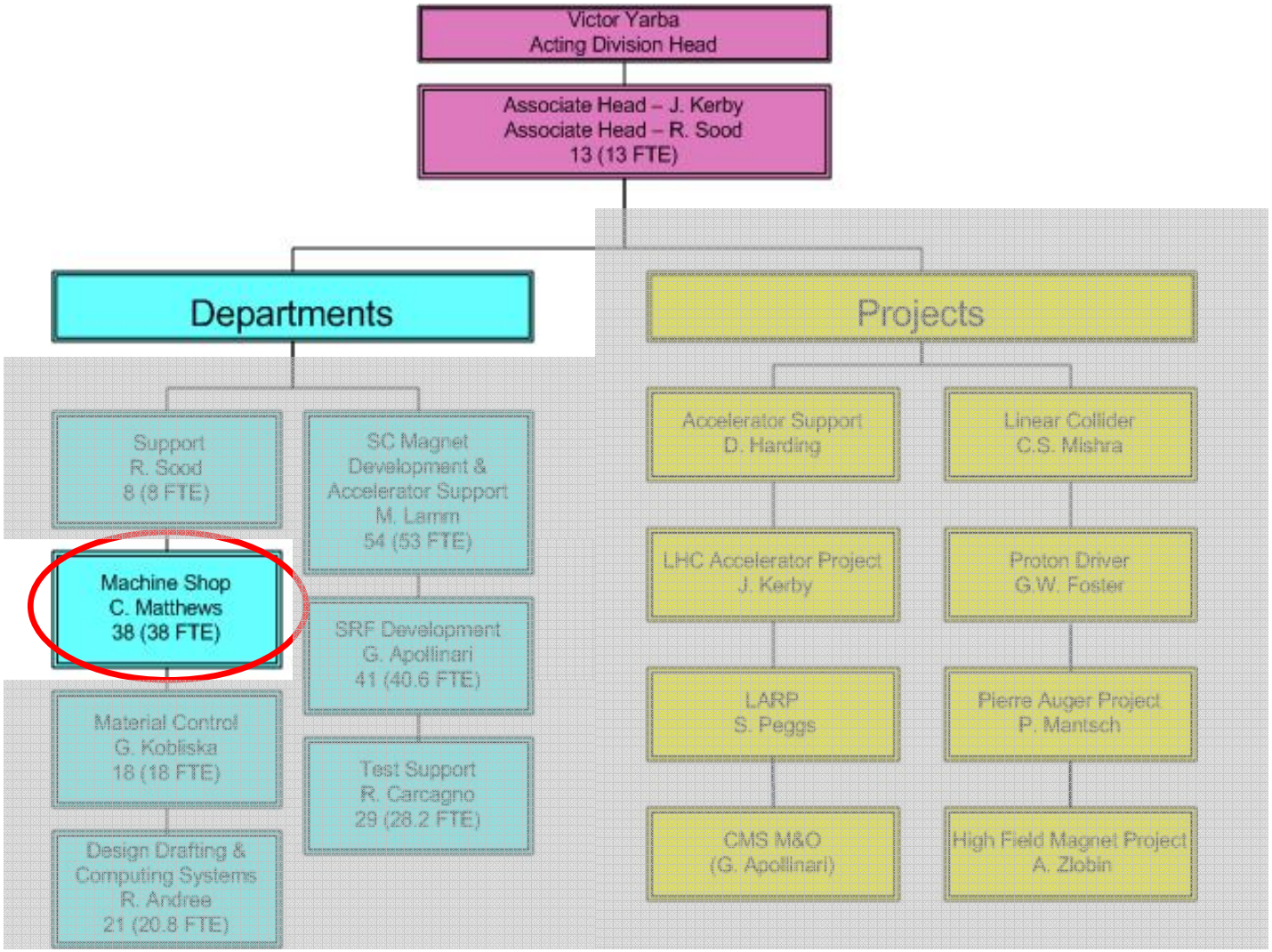
New equipment is requested through the yearly laboratory equipment funding process

The Shop is flexible. In addition to the Village Shop, satellite shops exist closer to users in

- **The HiRise (principally AD support)**
- **Meson Assembly Building (PPD)**
- **MW9 (AD-Cryo)**
- **IB4 (TD)**

The principle advantage of satellite shops being the close relationship our machinists can achieve and maintain with the groups they are working with through the life of R&D and specialty projects

Technical Division Organization



Machine Shop Personnel

The Shop is actively managed to maintain strengths and capabilities consistent with the needs of the laboratory and the availability of off-site resources

- **Staff reductions over the past 5 years with retirements, both regular and in lab wide programs (2002 and 2005)**
  - Level is current minimum, in fact we have a posted opening
- **Closing of the cut shop to utilize available off site inventory**
- **Increased Training of Shop personnel in CNC skills**
- **New purchases of CNC machines for rapid prototyping of accelerator and detector components, EDM cutting of Nb disks, precision machining of detector components, …**

	FY 2000	FY 2001	FY 2002	FY 2003	FY2004	FY2005	FY2006
Machinist	45	45	44	40	36	32	24
Welder	13	15	11	10	10	10	9
TOTAL Permanent	**58**	**60**	**55**	**50**	**46**	**42**	**33**

Shop Performance

In 2005:

- **Fermilab purchased about 117M$ of goods and services.**
- **Of the 117M$, direct machining work accounted for 5.3M$**
- **Of the 5.3M$**
  - 3.1M$ was to the Fermilab Machine Shops, average cost = $1277
  - 2.2M$ was to outside Machine Shops, average cost = $4044

The Fermilab shops serve the niche market, with small tasks averaging less than 24 total working hours

Larger machining jobs are sent off site

- **FNAL shops do not control the placement of orders, nor do they have the right of first choice on orders**

National Lab Shop Peer Group

In 2002 and 2003 Fermilab participated in Peer Groups on Machine Shop services with multiple other national laboratories.

The report:

- **Supports the need for targeted shops**
- **Notes the different charge back methods, task allocation methods, and capabilities across the laboratories**
- **Encourages continued meetings and exchange of information**

The meetings were not continued after 2003

We keep in touch with our colleagues at ANL

- **others as needed on a project by project basis**

Comparison to Other National Labs

As part of the 2002 Peer Group our rates were compared to other labs.

In late 2005 we updated this survey. We also conducted a survey of our shop rates as compared to other local shops (note FY06 rate is $59/hr)

	FNAL	ANL	ORNL	LLNL	SLAC	JLab	LBNL
Conventional Machining	$55.00	$80.00	$69.87	$75.00	$75.00	$47.00	$100.00
CNC Machining	$55.00	$88.00	$69.87	$75.00	$75.00	$47.00	$100.00
Optics	n/a	$88.00					
Inspection	n/a	$88.00					
Sheet Metal	$55.00	$87.00					
Machine Repair	$55.00	$88.00	$69.87			$47.00	
Conventional Welding	$55.00	$82.00	$69.87			$47.00	$100.00
Cut Shop	n/a	$75.00	$69.87			$47.00	$100.00
Electron Beam Welding	n/a	$109.00					
Hydrogen Vacuum Brazing	n/a	$109.00					
Pays Rent for Space	No	Yes	No	Yes			
Budgeted Equipment Funds Every Year	Yes?	Yes					
Union or Nonunion Shop	Union	Union	Union	Nonunion		Nonunion	
Able to Hire Contract Machinist During Workload Spikes				Yes			

Nov 2005 rate comparison

Comparison to Other Shops

Outside Vendor Hourly Rate Survey

			Updated:	November 9, 2001 November 16, 2005	
	Vendor-A	Vendor-B	Vendor-C	Vendor-D	Vendor-E
Large Manual Milling/ Lathe	--	$100**	--	$50-$60	--
EDM	--	$45-$75*	$35-$60*	--	--
Manual Milling/Lathe	$55	$55-$65	--	$50-$55	$50
CNC Milling/Lathe	$60-$70	$55-$65	--	$50-$60	$50-$60
Welding	$55-$65	--	--	$50	--
Metal Work (Forming)	$55-$70	--	--	--	--

*Rate difference may depend on several factors, including required operator skill and/or attention. Some jobs can run unattended, or with little operator interface, and can therefore be profitable at the lower rate.
**Multi-Axis machine tool.

Conclusion

The 2005 Ops review asked that Fermilab find several areas with high potential for savings and compare practices with other laboratories.

As a matter of practice in managing the Machine Shop, FNAL has been doing this comparison for the past several years.

We believe the Fermilab Machine Shop will continue to serve a vital role in the development of components needed for the continued success of Fermilab.

- **It serves a vital niche market in precision, response time, and interaction with users.**
- **It is actively managed and properly sized**
- **It is very comparable with other National Laboratory shops**
- **It is very competitive with outside local shops**